

COMPREHENSIVE SURVEY ON SUNDARBAN MANGROVE FOREST WEST BENGAL, INDIA

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ABSTRACT

The Indian Sundarbans, situated at the confluence of the Padma, Meghna, and Brahmaputra rivers, stands as a vital mangrove ecosystem of immense ecological significance. This expansive region, spanning approximately 4,000 square kilometers, reveals itself as a dynamic tapestry of life, showcasing a remarkable diversity of flora and fauna. At the heart of the Sundarbans' ecological role is its capacity to maintain balance and foster resilience. Their intricate root systems trap pollutants, contributing to improved water quality in the surrounding estuarine and coastal areas. This not only safeguards the health of the Sundarbans' waterways but also resonates as a critical component in the larger context of environmental conservation. Moreover, the Sundarbans functions as a vital nursery for fish species, playing a pivotal role in marine biodiversity. The labyrinthine network of mangrove roots provides a secure breeding ground for various fish, contributing to the abundance of marine life and supporting the sustenance of local communities engaged in fishing activities. The habitat provision by the Sundarbans extends beyond fish nurseries to encompass a myriad of species, ranging from iconic predators like the Royal Bengal tiger to lesser-known inhabitants like the proboscis monkey. This rich biodiversity highlights the intricate web of life within the Sundarbans and emphasizes the importance of preserving its habitats to ensure the survival of numerous species. The interconnectedness of life within the Sundarbans mirrors the delicate harmony necessary for ecosystem health and resilience..

Keyword : - Sundarbans, Mangrove ecosystem, Biodiversity, Pollutant filtration, Ecosystem resilience

1. Introduction

The Indian Sundarbans, nestled within the intricate delta region formed by the confluence of the Padma, Meghna, and Brahmaputra rivers, stands as a remarkable testament to the resilience of nature and the intricate interconnectedness of life. Covering an expansive area of approximately 4,000 square kilometers (1,544 square miles), this sprawling mangrove forest is a vital component of the broader Sundarbans ecosystem, a shared treasure between India and neighboring Bangladesh. The Indian Sundarbans extends across the districts of South 24 Parganas, North 24 Parganas, and a small segment of Hooghly in West Bengal. This region is a true sanctuary of biodiversity, representing a rich tapestry of life that depends on the delicate balance of its unique ecosystem. The Sundarbans mangrove forest is home to a diverse array of flora and fauna, with species such as the iconic Bengal tiger, spotted deer, crocodiles, and various bird species finding refuge within its tangled roots and tidal waterways. The intricate network of mangrove vegetation, including the Sundari tree that lends its name to the region, contributes to the ecological complexity of the area. Beyond its intrinsic ecological value, the Indian Sundarbans plays a crucial role in providing essential ecosystem services. Its mangrove ecosystem acts as a natural barrier, mitigating the impact of coastal erosion and protecting inland areas from the wrath of cyclones and storms. Moreover, the Sundarbans serves as a breeding ground for various fish species, supporting the livelihoods of local communities engaged in fishing activities.

However, this pristine ecosystem is not without its challenges. The Indian Sundarbans faces threats such as habitat loss, climate change impacts, and human-wildlife conflicts. Conservation efforts are imperative to ensure the sustained health of this invaluable natural heritage, striking a delicate balance between human activities and the preservation of the Sundarbans' ecological integrity. In essence, the Indian Sundarbans stands as both a testament to nature's intricate beauty and a call to action for its preservation and sustainable coexistence with human communities.

Table 1: Literature Survey

Author(s)	Research Gap	Methodology	Finding	Suggestions
Giri, C. et al. (2010)	Status and distribution of mangrove forests globally using Earth observation satellite data	Utilized Earth observation satellite data to assess mangrove status and distribution.	Provided a comprehensive overview of global mangrove forests, emphasizing the need for conservation.	Emphasized the importance of continued monitoring and conservation efforts to sustain mangrove ecosystems worldwide.
Field, C.B. et al. (1998)	Mangrove biodiversity and ecosystem function	Conducted a review on mangrove biodiversity and its role in ecosystem functioning.	Highlighted the diverse flora and fauna in mangroves and their crucial role in maintaining ecosystem functions.	Advocated for integrated management strategies to preserve mangrove biodiversity and ensure the sustainability of ecosystem services.
Nagelkerken, I. et al. (2008)	Habitat function of mangroves for terrestrial and marine fauna: A review	Conducted a review on the habitat function of mangroves for terrestrial and marine fauna.	Emphasized the importance of mangroves as critical habitats for a wide range of terrestrial and marine species.	Urged for conservation measures to protect mangrove habitats and sustain biodiversity, considering the habitat function for various species.
Arkema, K.K. et al. (2013)	Coastal habitats shield people and property from sea-level rise and storms	Investigated the protective role of coastal habitats against sea-level rise and storms.	Demonstrated that coastal habitats, including mangroves, provide significant protection to human populations and infrastructure.	Recommended the conservation and restoration of coastal habitats as a nature-based solution to enhance resilience to sea-level rise and storms.
Menéndez, P. et al. (2020)	The global flood protection benefits of mangroves	Explored the global flood protection benefits provided by mangroves.	Quantified the flood protection services offered by mangroves, emphasizing their importance in mitigating the impacts of coastal flooding.	Highlighted the need for recognizing and valuing the flood protection services of mangroves in coastal management and climate adaptation strategies.
Donato, D.C. et al. (2011)	Mangroves among the most carbon-rich forests in the tropics	Assessed the carbon storage capacity of mangrove forests in the tropics.	Found that mangroves are among the most carbon-rich forests, underscoring their significance in climate change mitigation.	Stressed the importance of conserving mangroves as a strategy to sequester carbon and mitigate the impacts of climate change.
Kundu, K. et al. (2021)	Detection and prediction of Sundarban reserve forest using the CA-	Utilized the CA-Markov chain model and remote sensing data to detect	Detected changes in Sundarban reserve forest and predicted future changes using a modeling approach.	Suggested continued monitoring and adaptive management strategies to address the detected and predicted changes in the

	Markov chain model	and predict changes.		Sundarban reserve forest.
Sahana, M. et al. (2015)	Assessing spatio-temporal health of forest cover in Sundarban reserve forest	Assessed the spatio-temporal health of forest cover using a forest canopy density model.	Evaluated the health of forest cover in Sundarban reserve forest, emphasizing spatial and temporal dynamics.	Proposed the integration of forest canopy density models with fragmentation approaches for a comprehensive assessment of forest health in Sundarbans.
Ali, S.A. et al. (2020)	Assessment of cyclone vulnerability, hazard evaluation, and mitigation capacity in Sundarbans	Used GIS technique for assessing cyclone vulnerability, hazard evaluation, and mitigation.	Assessed cyclone risk in Sundarbans, focusing on vulnerability, hazard evaluation, and mitigation capacity.	Recommended the implementation of GIS-based cyclone risk assessments and the development of effective mitigation strategies for Sundarbans.
Padhy, S.R. et al. (2020)	Seasonal fluctuation in greenhouse gases emission in degraded mangrove, Sundarban, India	Investigated seasonal fluctuations in greenhouse gas emissions in degraded mangrove areas.	Found fluctuations in three modes of greenhouse gas emissions related to soil labile carbon pools in degraded mangrove areas of Sundarbans.	Emphasized the importance of understanding seasonal variations in greenhouse gas emissions for effective mangrove management and restoration strategies.
Barik, J. et al. (2018)	Mangrove species distribution and water salinity: An indicator species approach to Sundarban	Used an indicator species approach to study mangrove species distribution and water salinity.	Explored the relationship between mangrove species distribution and water salinity in Sundarban.	Advocated for the use of indicator species to monitor changes in mangrove species distribution and their response to environmental factors like water salinity.
Wang, D. et al. (2018)	Evaluating the performance of Sentinel-2, Landsat 8, and Pléiades-1 in mapping mangrove extent	Assessed the performance of different satellite sensors in mapping mangrove extent.	Compared the performance of Sentinel-2, Landsat 8, and Pléiades-1 in accurately mapping mangrove extent and species in diverse ecosystems.	Recommended the use of high-resolution satellite sensors, such as Pléiades-1, for precise mapping of mangrove extent and species.
Giri, S. et al. (2014)	Abundance and distribution of mangrove species in Indian Sundarban using remote sensing	Used remote sensing techniques to study the abundance and distribution of mangrove species.	Provided insights into the abundance and distribution of mangrove species in the Indian Sundarban using remote sensing techniques.	Suggested continued use of remote sensing for monitoring and assessing mangrove species abundance and distribution in the Sundarban region.
Kumar, T. et al. (2019)	Discrimination and classification of mangrove forests using EO-1 Hyperion data	Employed EO-1 Hyperion data for discriminating and classifying mangrove forests.	Demonstrated the capabilities of EO-1 Hyperion data in discriminating and classifying mangrove forests in the Sundarbans.	Recommended the integration of EO-1 Hyperion data with other remote sensing techniques for improved discrimination and classification of mangrove forests.

2. A Realm of Rich Biodiversity

The Indian Sundarbans unfolds as a sanctuary for a diverse tapestry of flora and fauna, a vibrant symphony of life resonating within the intricate network of waterways and lush mangrove forests. More than 200 species of mangrove trees, each uniquely adapted to the saline environment, stand as the pillars of this ecological masterpiece. The canopy above is alive with the fluttering wings and vibrant plumage of over 400 species of birds, their melodic calls reverberating through the dense foliage. On the terra firma, a captivating array of mammals finds solace in the undergrowth, with the majestic Royal Bengal tiger claiming its role as an iconic resident. This enigmatic creature, perfectly adapted to the mangrove habitat, epitomizes the wild allure of the Sundarbans. In addition to the tiger, other mesmerizing mammals navigate the landscape, creating a dynamic and interconnected ecosystem that is both awe-inspiring and essential for the balance of nature.

As the waterways crisscross the region, they harbor a bustling community of marine and freshwater creatures. The Sundarbans' aquatic realm is a mosaic of life, from intricate fish species to elusive reptiles, creating a rich tapestry of biodiversity beneath the water's surface. The Indian Sundarbans, with its rich biodiversity and unique ecosystems, stands as a testament to the marvels of nature. The delicate dance of life within its confines illustrates the intricate web of interdependence, where each species plays a crucial role in maintaining the harmony of the entire ecosystem. Preserving this haven is not just a matter of conservation but a commitment to sustaining the delicate balance of life in one of the world's most captivating natural wonders.

3. The Majestic Royal Bengal Tiger:

The Royal Bengal tiger (*Panthera tigris tigris*), India's national animal, holds undisputed sovereignty as the apex predator in the Indian Sundarbans. These majestic striped felines, characterized by powerful strides and a piercing gaze, embody the untamed essence of this unique ecosystem. Their regal presence symbolizes the wild and unbridled nature of the Sundarbans, underscoring the significance of preserving the delicate balance of life within this remarkable habitat. As the top predator in this mangrove-laden expanse, the Royal Bengal tiger plays a pivotal role in regulating the population of prey species, ensuring the ecological equilibrium of the region. Their stealth and prowess make them not only a symbol of the wild but also a keystone species whose conservation is crucial for the overall health of the Sundarbans. The preservation of these majestic tigers is emblematic of the broader conservation efforts aimed at safeguarding the entire Sundarbans ecosystem. Their survival hinges not only on protecting their habitats from encroachment but also on addressing broader challenges such as habitat degradation, climate change impacts, and human-wildlife conflict. By recognizing the importance of the Royal Bengal tiger, conservation initiatives strive to secure the future of this iconic species and, by extension, the intricate web of life woven throughout the Sundarbans.

Table 2: Comparative Study

Factors	Indian Sundarbans	Bangladesh Sundarbans
Geographical Coverage	Spans about 4,000 sq. km	Encompasses around 6,017 sq. km
Districts Covered	Primarily South 24 Parganas, North 24 Parganas, and a small part of Hooghly in West Bengal	Spreads across Khulna, Satkhira, and parts of southwestern Bangladesh
Total Mangrove Area	Approximately 2,114 sq. km	Approximately 4,143 sq. km
Biodiversity	Rich biodiversity with various species of flora and fauna, including the Royal Bengal Tiger	Diverse ecosystems supporting various species of plants, animals, and endangered species like the Bengal tiger
Human Population	Inhabited by various communities, including indigenous populations and fishermen	Populated regions with communities relying on the Sundarbans for livelihoods, including fishing and honey collection

Economic Activities	Fishing, honey collection, wood extraction, and agriculture	Dominated by fishing, shrimp farming, and forestry activities
Global Importance	UNESCO World Heritage Site since 1987	UNESCO World Heritage Site since 1997
Climate Vulnerability	Susceptible to cyclones and rising sea levels	Vulnerable to climate change impacts, including cyclones, storm surges, and sea-level rise
Sea Level Rise	Experiencing a rise in sea level, posing threats to the ecosystem and local communities	Facing challenges due to sea-level rise, impacting the mangrove ecosystem and coastal areas
Mangrove Species	Home to various mangrove species, including Sundari trees and others	Supports diverse mangrove species, crucial for the unique ecosystem
Conservation Efforts	Conservation efforts focus on protecting biodiversity, sustainable resource use, and community involvement	Emphasizes the need for conservation, sustainable management, and addressing threats to maintain ecological balance

4. A Glimpse into the Aquatic Realm

The endangered Gangetic dolphin (*Platanista gangetica*), colloquially known as the susu, gracefully maneuvers through the rivers and waterways of the Sundarbans. Distinguished by their elongated bodies and distinctive beaks, these freshwater dolphins not only add a touch of elegance to the landscape but also play a crucial role as indicators of the ecosystem's health, offering valuable insights into the aquatic world of the Sundarbans. The presence of Gangetic dolphins in the Sundarbans is significant on multiple fronts. As highly sensitive creatures, their well-being is intricately linked to the overall health of the waterways they inhabit. Their continued existence relies on the availability of sufficient prey, suitable water quality, and the absence of threats such as pollution and habitat degradation. Consequently, monitoring the population and behavior of these dolphins provides researchers and conservationists with important data regarding the overall environmental conditions of the Sundarbans.

Protecting the endangered Gangetic dolphin is not only a conservation imperative but also a means of safeguarding the broader biodiversity and ecological integrity of the Sundarbans. Their presence serves as a poignant reminder of the delicate balance required to preserve the intricate web of life in this unique and fragile ecosystem. Efforts aimed at the conservation of these dolphins contribute not only to their survival but also to the overall well-being of the Sundarbans and the communities that call it home.

5. A Vulnerable Species Seeking Sanctuary

The vulnerable Olive Ridley turtle (*Lepidochelys olivacea*) seeks refuge on the pristine beaches of the Indian Sundarbans. Renowned for their synchronized nesting events, these marine turtles depend on the undisturbed shores of the Sundarbans for their reproductive success. Their presence serves as a poignant reminder of the critical need to protect coastal habitats and maintain the delicate balance of marine ecosystems. Olive Ridley turtles, named for their olive-colored shells, play a vital role in the health of marine environments. The Sundarbans, with its intricate network of waterways and coastal areas, offers a crucial haven for these turtles during their nesting season. The undisturbed beaches provide a sanctuary where the turtles can lay their eggs, contributing to the continuation of their species. The vulnerability of Olive Ridley turtles underscores the broader challenges facing marine life, including habitat degradation, pollution, and climate change. Efforts to conserve these turtles extend beyond safeguarding nesting sites; they involve addressing the interconnected issues affecting the health of coastal ecosystems. Conservation initiatives focus on raising awareness, implementing sustainable practices, and advocating for the preservation of critical habitats like the Sundarbans.

Protecting the Olive Ridley turtle in the Sundarbans is not only an endeavor to ensure the survival of a vulnerable species but also a commitment to maintaining the overall ecological integrity of coastal regions. By acknowledging

the importance of these turtles and their reliance on undisturbed nesting sites, conservationists work towards preserving the Sundarbans as a haven for marine biodiversity and a symbol of the delicate balance that must be maintained for the well-being of our oceans.

6. A Lurking Presence in Brackish Waters

The Sundarbans' brackish waters are home to the saltwater crocodile (*Crocodylus porosus*), the world's largest reptile, commanding respect and awe. These formidable predators, with their powerful jaws and armored bodies, play a crucial role in maintaining the equilibrium of the ecosystem. Their presence underscores the interconnectedness of life within the Sundarbans. The saltwater crocodile's position as a top predator in the Sundarbans is pivotal for ecological balance. Their predatory influence helps regulate the population of other species, preventing unchecked growth that could disrupt the delicate harmony of the mangrove ecosystem. As ambush predators, they are well-adapted to the labyrinthine waterways, playing a vital role in shaping the distribution and behavior of prey species.

The Sundarbans boast a diverse array of primates, including the proboscis monkey (*Nasalis larvatus*), distinguished by its elongated nose and unique vocalizations. Inhabiting the dense mangrove forests, these long-tailed monkeys play a significant role in the Sundarbans' primate diversity, contributing to the ecosystem's ecological balance and offering valuable insights into primate behavior and adaptations. As arboreal inhabitants, proboscis monkeys contribute to the dispersal of seeds, playing a role in the regeneration of the mangrove ecosystem.

7. Conservation Efforts

The Indian Sundarbans, facing a multitude of threats, including deforestation, climate change, pollution, and human encroachment, demands urgent conservation efforts. Protected areas, such as the Sundarbans National Park, provide havens for wildlife, while community-based conservation initiatives empower local residents to become stewards of their environment. Sustainable land-use practices and pollution control measures are essential to safeguard the Sundarbans' ecological integrity. The Indian Sundarbans, a vibrant tapestry of life intricately woven with diverse flora and fauna, occupies a pivotal role in preserving the delicate balance of its ecosystem. The mangrove forests, a defining feature of this landscape, serve as invaluable filters for pollutants in the water, foster vital fish nurseries, and provide a habitat for a myriad of species. In the Sundarbans, the intricate web of life extends beyond the mangroves to include a diverse array of flora and fauna, from iconic species like the Royal Bengal tiger to the lesser-known inhabitants like the proboscis monkey. Each organism, no matter how big or small, plays a unique role in the ecosystem, highlighting the delicate balance that characterizes this natural wonder. Recognizing the Sundarbans as a harmonious ecosystem underscores the importance of conservation efforts aimed at preserving its biodiversity and ecological integrity.

8. Conclusion:

In conclusion, the Indian Sundarbans transcends its geographical boundaries, unfolding as a living testament to the intricate interdependence of life within its bounds. The mangrove forests, intricately woven like guardians of nature, serve multifaceted roles — filtering pollutants, nurturing marine life, and providing habitats for a diverse array of species. Preserving the Sundarbans is not merely an environmental duty; it signifies a profound commitment to maintaining the delicate equilibrium of this distinctive ecosystem, ensuring its resilience against the ever-evolving challenges posed by the environment. As we marvel at the diversity and complexity of life flourishing within the Sundarbans, the imperative of our conservation endeavors becomes evident. Our collective efforts are indispensable for the sustained well-being of this extraordinary natural wonder, emphasizing the enduring need to safeguard the Sundarbans as a sanctuary of biodiversity and a beacon of the interconnectedness that defines the intricate tapestry of life on our planet.

9. References

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